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Spruce Budworm Evaluation on the Superior National Forest - 1969

By Glen Erickson and Imants Millers

ABSTRACT

Defoliation of fir and spruce by the spruce budworm, Choristoneura fumiferana (Clem.), covers about 140,000 acres of spruce-fir type on the Superior National Forest. Of this total acreage, about 110,000 acres are classed as severely defoliated. High egg-mass populations indicate that the budworm outbreak will continue into 1970. Tree mortality is ex pected unless additional defoliation is prevented. Budworm populations can be reduced by either natural control agents or chemical suppression. The Superior National Forest is advised to consider the resource values affected and the need for suppression. Conversion from fir to non-host tree species is suggested for recreational areas.

INTRODUCTION

The spruce budworm, Choristoneura fumiferana (Clem.), is one of the most devasting insect pests of spruce-fir forests in North America. Blais (1968) reviews spruce budworm outbreak history in North America during the last 250 years. The earliest record in Minnesota is the 1911 outbreak, when more than 20 million cords of balsam fir were estimated killed (Graham and Orr, 1940). The next budworm outbreak occurred from 1954 to 1963, when more than 1.5 million cords of pulpwood were killed (Weber, 1964). The budworm population declined rapidly in 1963 (Ryan and Batzer, 1964), and it was considered endemic until 1967.

The current outbreak of the spruce budworm was first detected in 1967. Ground and aerial surveys revealed about 40,000 acres of gross area (including non-host types within outbreak boundary) defoliated. Stands in several locations appeared to be in the second or third year of defoliation. In 1968 defoliation was observed on 130,000 acres of spruce/fir type of which about 100,000 acres were classes as moderately to severely defoliated (Millers, I., et. al., 1968).

This report presents the 1969 evaluation of the spruce budworm and is based primarily on aerial defoliation and egg-mass surveys.

BIOLOGICAL REVIEW

A. Causal Agent

Spruce budworm, Choristoneura fumiferana (Clem.)

B. Host Trees Attacked

Balsam fir, Abies Balsamea (L.) Mill.
White spruce, Picea glauca (Moench) Voss

C. Type of Damage

Damage occurs as a result of larval feeding on needles and mining of buds. Current foliage and buds are damaged first. Older foliage is damaged after the preferred food supply is exhausted. Severe defoliation for 3 or more successive years results in tree mortality (Bean and Waters, 1961).

D. Ecological Considerations

Many parasites, predators and diseases attack the spruce budworm, but their role in outbreak suppression appears to be minor (Bean and Waters, 1961; Morris et al., 1963). Adverse weather is reported as a budworm mortality factor elsewhere (Wellington, 1954), however, on the Superior National Forest the current outbreak has increased during 3 years of apparently unfavorable weather, i.e. cool and wet springs and summers.

SURVEY METHODS

Aerial

Spruce budworm defoliation was first mapped during the Forest tent caterpillar aerial survey (in cooperation with the Minnesota Department of Agriculture), July 7 and 9, 1969. A second mapping, primarily of tree mortality and top-kill, was obtained during the Jack-pine budworm aerial survey (also in cooperation with the Minnesota Department of Agriculture) on August 14 and 15, 1969. Both surveys followed the basic aerial survey methods used in the Lake States. The flights were at 100 mph, about 1000 feet above the ground, and in parallel lines 6-12 miles apart, depending

on host type and damage. The observed damage was sketch-mapped on 1/2" to mile Minnesota Highway Department maps.

Ground Survey

The ground survey was made in late August and early September. Samples were taken from 39 balsam fir plots and 20 white spruce plots (distribution of plots is shown in Maps 1 and 2). A sample consists of three 15" twigs, taken from mid-crown, from each of 3 trees (total of 9 twigs per plot). The plots were located along roads where automobile access was possible. Each twig was examined by the Eveleth Nursery crew for defoliation and egg-masses. The Boundary Waters Canoe Area (northern part of the Forest) was not ground checked because of difficulty of access. (For detailed methods see Appendix.)

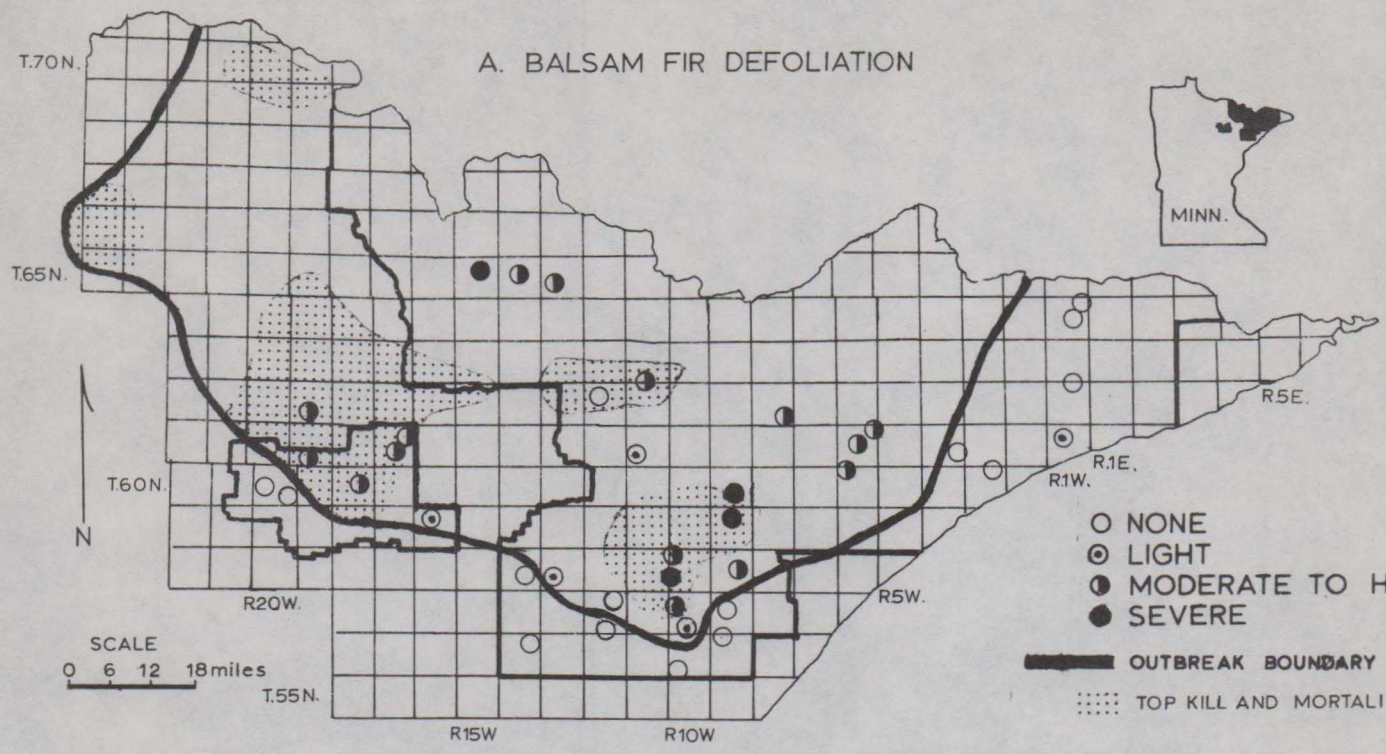
DEFOLIATION IN 1969

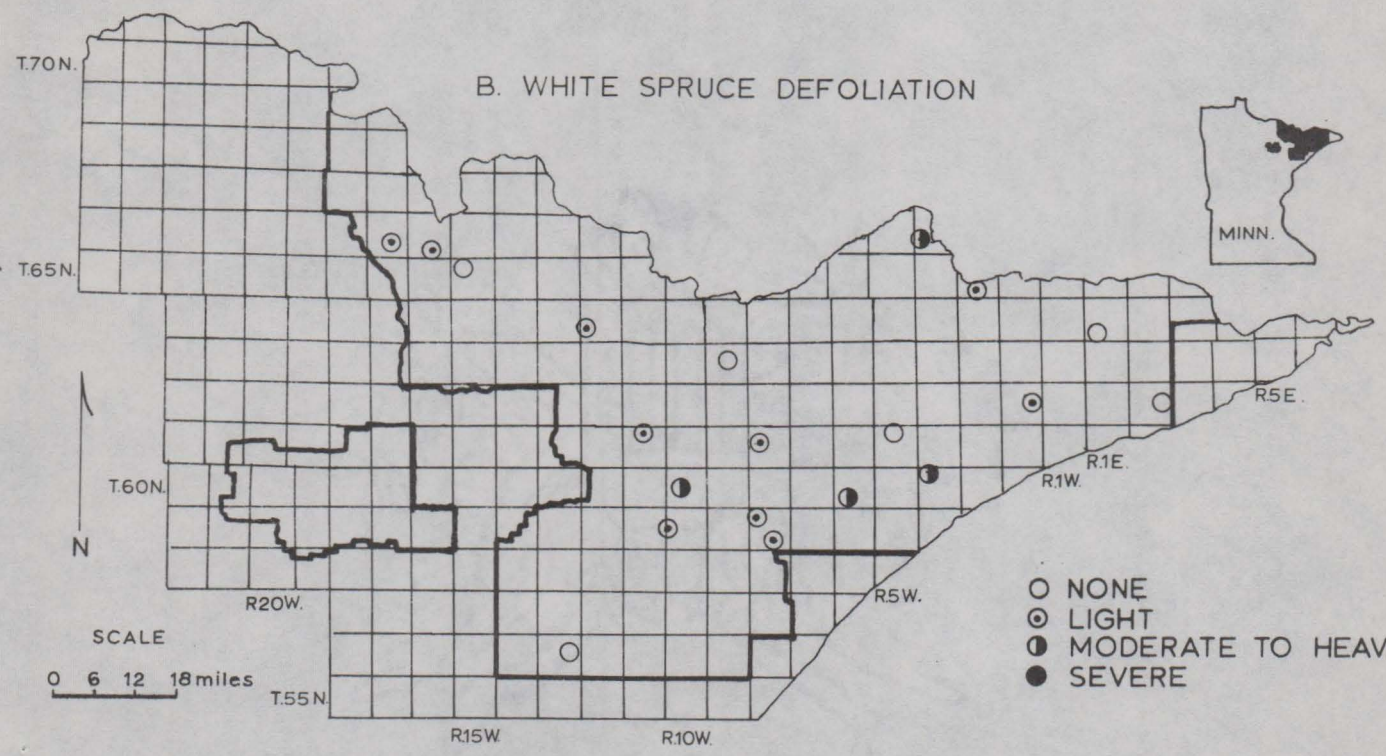
About 140,000 acres of spruce-fir type on the Forest is defoliated by the spruce budworm. The outbreak boundary shown in Map 1 is based on various observations during the aerial and ground surveys. In 1969, about 30,000 acres more were defoliated than the preceeding year. In general, defoliation intensity appears to have declined in the northern part of the Forest, while increasing toward the south and east. Plot defoliation estimates shown on the maps probably are underestimates. The twig samples were biased in favor of healthier trees where eggs were more likely to occur. Defoliation estimates for spruce plots and fir plots are shown separately.

The areas where top-kill and tree mortality was observed during the aerial surveys is shown on Map 1A. The damage generally occured in scattered small pockets. Losses were primarily among the older balsam fir. No spruce mortality was found.

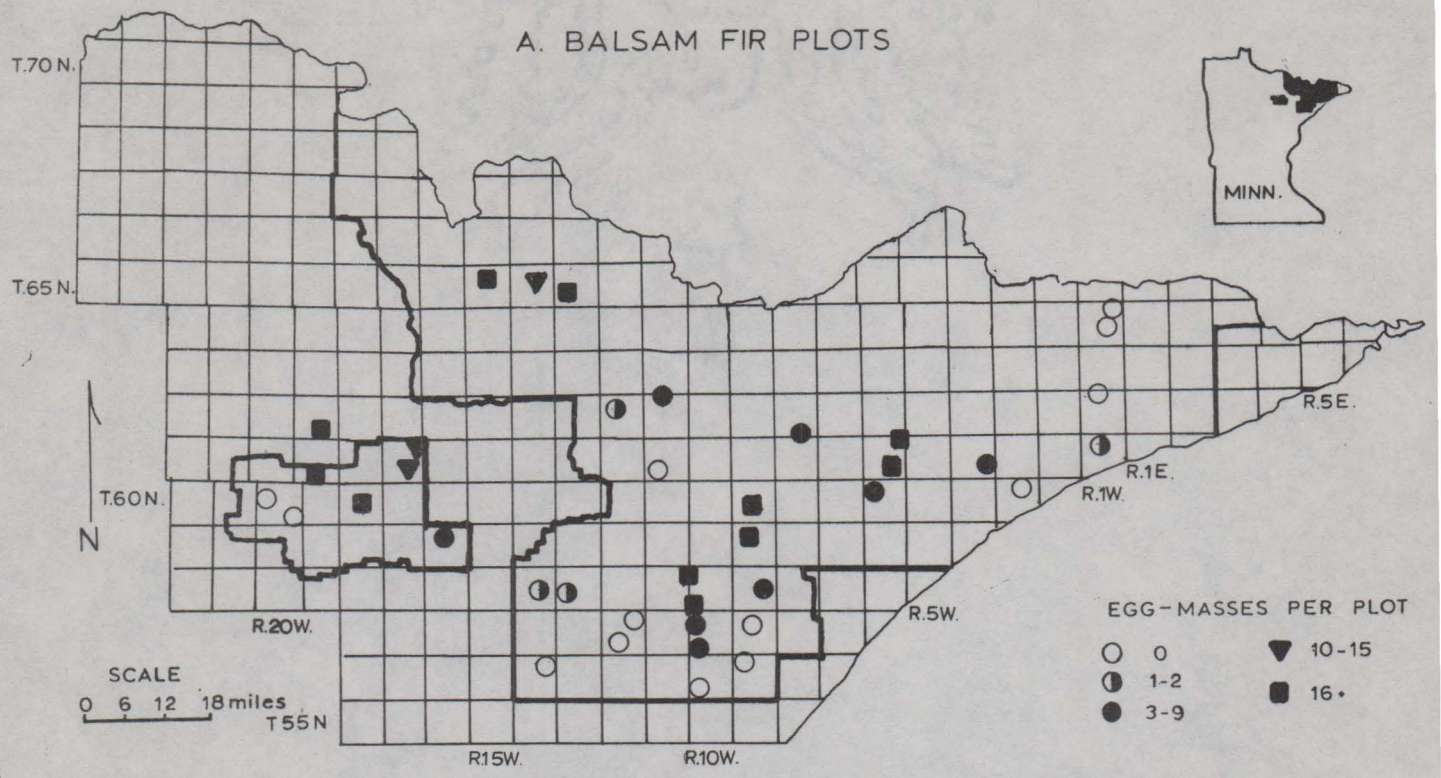
Future Trend

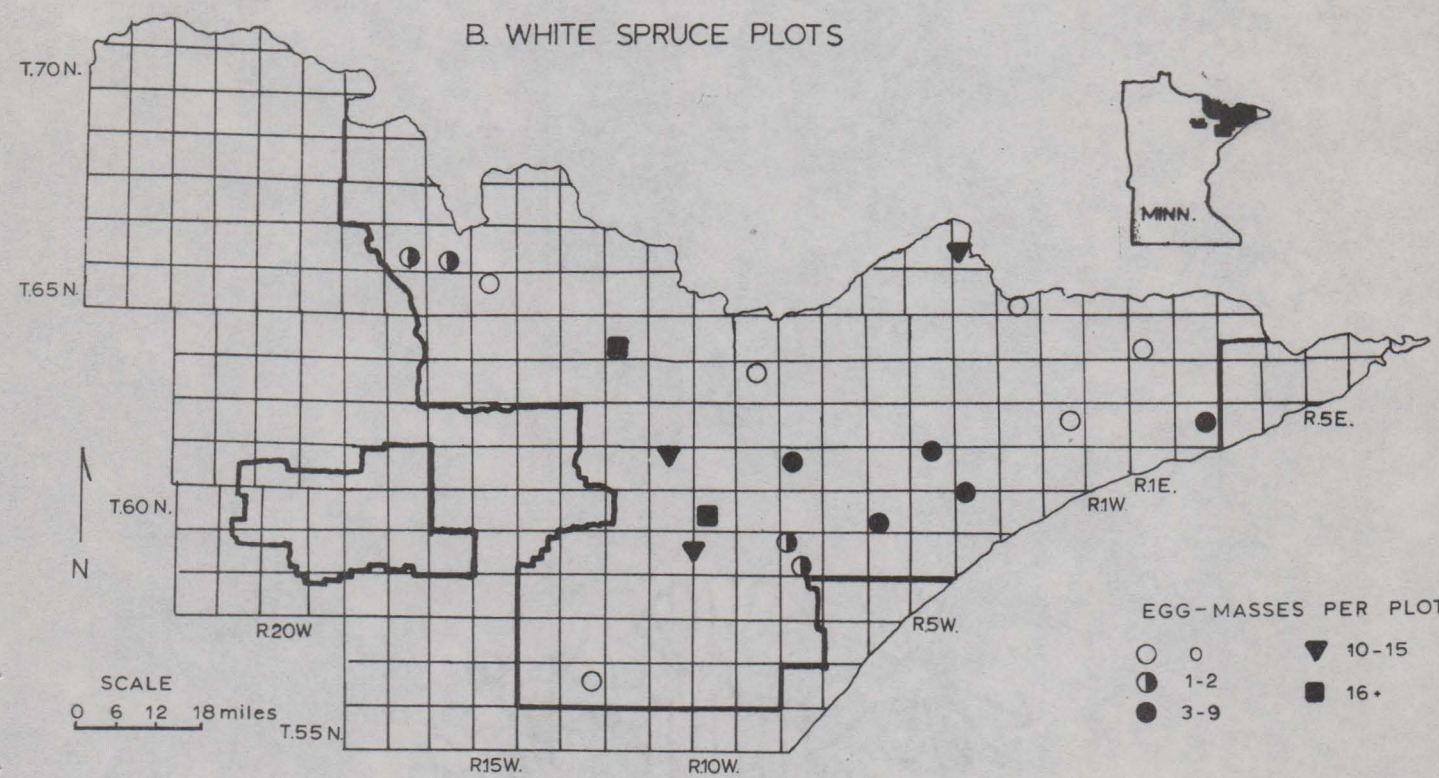
The egg-mass survey is made to predict the future trend of the budworm population. Map 2A shows the distribution and approximate levels of budworm population on balsam fir, and Map 2B shows the same as based on white spruce data. The data suggest that an eastward expansion of the budworm outbreak can be expected in 1970. According to survey data for balsam fir (Table I), 12 plots have increased





Map 1. Spruce budworm defoliation on the Superior N.F. — 1969





Map 2. Egg-mass populations on the Superior N.F. -1969

Table I. Balsam fir plot data

Plot No.	Location			Egg-Masses Per Plot			Defoliation 1969			1970 Prediction[1/]
	T	R	S	'68	'69	Change	Predict[1/]	Actual	Error	
3	59	16W	9	0	3	+	NL	L	0	M
4	60	20W	35	0	0	0	NL	N	0	NL
5	60	20W	17	0	0	0	NL	N	0	NL
6	61	19W	29	16+	16+	0	S	S	0	S
7	60	18W	15	10	16+	+	M	M	0	S
8	61	17W	27	7	10	+	M	M	0	H
9	61	17W	23	16+	11	-	S	H	-	H
10	62	12W	8	16+	1	-	S	N	=	LM
11	61	11W	30	1	0	-	LM	L	0	NL
16	64	1W	1	0	0	0	NL	N	0	NL
17	64	1W	12	0	0	0	NL	N	0	NL
20	62	1W	4	0	0	0	NL	N	0	NL
23	61	1W	9	0	1	+	NL	L	0	LM
24	60	3W	3	1	0	-	LM	N	-	NL
25	61	4W	25	0	3	+	NL	N	0	M
29	61	6W	1	16	16	0	S	H	-	S
30	61	6W	14	16+	16+	0	S	M	-	S
31	60	6W	5	5	9	0	M	M	0	M
38	65	15W	10	16	16+	+	S	S	0	S
39	65	14W	9	16+	14	-	S	M	-	H
40	65	13W	19	16+	16+	0	S	H	-	S
43	58	13W	19	0	2	+	NL	L	-	LM
44	58	14W	23	3	1	-	M	N	-	LM
45	57	12W	11	0	0	0	NL	N	0	NL
46	57	12W	8	0	0	0	NL	N	0	NL
49	56	14W	1	0	0	0	NL	N	0	NL
104	62	8W	35	16+	7	-	S	H	-	M
108	60	9W	22	16+	16+	0	S	S	0	S
111	59	9W	10	11	16+	+	H	S	+	S
118	63	11W	33	16+	6	-	S	H	-	M
120	58	11W	12	16+	16+	0	S	H	-	S
121	58	10W	31	3	16+	+	M	S	+	S
122	57	10W	19	3	4	+	M	M	0	M
123	56	10W	31	0	0	0	NL	N	0	NL
124	57	10W	33	0	5	+	NL	L	0	M
125	56	9W	5	0	0	0	NL	N	0	NL
126	57	9W	16	0	0	0	NL	N	0	NL
127	58	9W	23	4	6	+	M	M	0	M
130*	62	19W	28	-	16+		-	M		S

1/ Defoliation code is as follows: N-none, L-light, M-moderate, H-heavy, S-severe, or combination of these

* A new plot established in 1969.

Table II. White spruce plot data

Plot No.	Location			Egg-Masses Per Plot			Defoliation 1969			1970 Prediction[1/]
	T	R	S	'68	'69	Change	Predict[1/]	Actual	Error	
2	61	11W	4	9	11	+	M	L	-	MS
13	66	4W	31	16+	15	-	S	H	-	MS
15	65	3W	34	1	0	-	LM	L	0	NL
18	64	1E	32	0	0	0	NL	N	0	NL
19	62	2E	14	0	5	+	NL	L	0	M
21	62	2W	14	2	0	-	LM	N	-	NL
26	60	4W	6	7	3	-	M	H	+	M
27	61	5W	3	6	3	-	M	L	-	M
33	60	6W	29	7	9	+	M	H	+	M
35	66	17W	26	10	2	-	M	L	-	LM
36	66	16W	33	16+	1	-	S	L	-	LM
37	65	15W	8	16	0	-	S	N	=	NL
42	64	12W	30	16+	16+	0	S	L	-	S
47	56	13W	14	0	0	0	NL	N	0	NL
101	61	8W	19	16+	8	-	S	M	-	M
110	59	8W	7	5	1	-	M	L	-	LM
112	59	11W	24	16+	15	-	S	L	-	MS
115	60	10W	21	16+	16+	+	S	H	-	S
117	63	9W	16	16+	0	-	S	N	=	NL
129	59	8W	33	0	1	+	NL	L	0	LM

1/ Defoliation code is as follows: N-none, L-light, M-moderate H-heavy, S-severe, or combination of these.

in egg-mass population from last year, 8 declined and 18 remained the same. However, Table II for white spruce shows that egg-mass populations declined in 12 plots, increased in 5 plots, and remained the same in 3 plots. The overall conclusion drawn from the egg-mass trends is that defoliation for the outbreak area will be moderate to severe, similar to what was experienced in 1969. Tables I and II show comparisons by plots for the defoliation predictions made in 1968 and the actual defoliation observed in 1969. For balsam fir 25 predictions were correcte , 11 were overestimated and 2 were underestimated. Only one serious error occurred, i.e. plot 10 was expected to have severe defoliation, but none was found.

The predictions for white spruce defoliation were less accurate (Table II). Only 5 correct predictions were made. In 2 plots slightly greater defoliation occurred than anticipated. Overestimates of defoliation were made in 13 plots, and 2 of those were predicted to have severe defoliation but no defoliation occurred in 1969. This suggests that the predictions of spruce defoliation are more difficult, and that the current prediction method tends to overestimate the following years defoliation.

Discussion

Spruce budworm defoliation on the Superior National Forest spread slightly to the east, but declined somewhat in severity. Tree damage, viz. top-kill and mortality, is limited to balsam fir and is becoming more common. Continued defoliation is expected, as well as eastward expansion of the outbreak. One may reasonable speculate that most of the mature balsam fir stands will be decimated. However, balsam fir regeneration is abundant and future supply of trees should not be reduced. The greatest apparent threat is to the recreation areas that depend on balsam fir cover.

Spruce budworm impact appears to be less severe on white spruce. While the defoliation probably is causing growth reduction, no visible damage, such as top-kill, has been observed.

The resource managers should consider each area affected to determine if fir mortality must be prevented. Since the total outbreak is not suppressed, local stands will

require chemical treatments every 2-3 years during the course of the outbreak to prevent tree mortality. Chemical suppression should be regarded as a temporary relief, since budworm hazard will continue. Conversion to non-host tree species, such as pines and some spruces, may be considered for recreation areas. Forest-wide conversion is not practical, since the natural trend of ecological succession is toward maintenance of balsam fir.

SUPPRESSION INFORMATION

DDT was used successfully during the 1962 Spruce budworm control project on the Superior National Forest. However, adverse side effects limit its use at present. Several insecticides have been extensively field tested as substitutes for DDT. Malathion, Phosphamidon, Sumithion, and Zectran have shown the most promise.

Malathion is the only one registered for use against spruce budworm. Tests of its effectiveness have yielded variable results. Because of the short residual effectiveness, precise timing of application and uniform coverage is essential. The adverse effects, i.e. hazards to fish and wildlife and human exposure, are low at the recommended rates. Malathion causes damage to acrylic lacquer type paints exposed to deposits of the concentrated material. When Malathion is used for spruce budworm control, the recommended rate is 13 fluid ounces per acre of Low Volume Concentrate (LVC). The estimated cost of the material is $1.00 per acre (10.14/gal.).

Phosphamidon has been tested in Canada (also in combination treatments with Sumithion). Results show that the material is toxic to birds but less so to fish. Single application rates in excess of 4 oz. per acre have reduced bird populations. Two applications of 1/8 lb. per acre about 10 days apart have been used without adverse effects. Cost estimates of the material at 4 oz. per acre are $1.14 per acre ($36.55 per gallon). Phosphamidon is extremely corrosive to spray equipment.

Sumithion is a new phosphate insecticide, and is not available from U. S. insecticide manufacturers. A supply may be available from Cyanamid of Canada, Ltd. It has no label registration for spruce budworm in the United States. A special label approval would have to be obtained through the Federal Committee on Pest Control before it can be used. Rates of application which have shown promise in Canadian tests are: (1) single application of 6 ounces (active ingredient) per acre,

(2) two applications, of 4 ounces per acre each, (3) one application of 4 ounces Sumithion and 4 ounces of Phosphamidon. Rates above 6 ounces/acre have caused bird mortality particularly to insect feeders. Sumithion at the recommended rates is not considered hazardous to humans. The estimated cost for material is about $0.84/acre ($17.97 per gallon for 8 lb. per gallon Sumithion emulsion concentrate).

Zectran, a carbamate insecticide, has been tested for control of the spruce budworm in the West with success. A pilot study in Maine, 1967, failed to achieve the required 95% population reduction set as a criteria for successful control. Zectran is non-hazardous at the low rates of application used in the West, (1.5-3 ounces per acre). No cost estimates are available and this material is not expected to be commercially available in 1970.

RECOMMENDATIONS

1. The Forest Manager is advised to determine the effects of the spruce budworm damage on the resources of the Superior National Forest.

2. Prevention of damage through conversion to non-host tree species in recreation areas is advisable.

3. Where balsam fir mortality must be prevented, the Forest Manager should consider chemical suppression.

4. The St. Paul Field Office will continue annual Biological Evaluations of the Spruce Budworm outbreak to inform the public and the landowners of the situation, and to provide outbreak progress information for the future, when balsam fir timber values become important.

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APPENDIX

SPRUCE BUDWORM
EGG-MASS SURVEY INSTRUCTIONS

By I. Millers

OBJECTIVE:

To locate spruce budworm outbreak centers; to measure the degree of defoliation and to estimate the egg-mass population.

METHODS:

1. Sample - the sampling unit is number of egg masses per 15" of sample twig. Twigs cut from mid-crown, 3 per tree.

2. Plot - the sample plot is a cluster of 3 dominant balsam fir or white spruce.

3. The sampling scheme - plots are located in easily accessible areas of balsam fir type. Attempt is made to achieve systematic geographic scatter. Where the type is abundant, at least 1 plot per 2 miles of road is sampled. However, most plots are wider spaced because of the scattered type.

4. Collecting samples - the plots are located in a typical part of stand representative of the whole stand. The 3 twigs are cut and tied together in a bundle. The 3 bundles from a plot are placed in a cloth bag with properly labelled card (SB 5230-1). The plot number should be recorded on the survey map showing the exact location and on the card (SB 5230-1).

5. Defoliation estimates -

   (a) field - an estimate is made of current defoliation in the area of the plot. If there is a difference between the plot trees and the vicinity a note is made on the card (SB 5230-1).

(b) Laboratory - an estimate is made of current defoliation for each 15" twig. The following classes are used:

0 - no defoliation; less than 5% defoliation
1 - 1/4 defoliation; 6-40% defoliation
2 - 1/2 (2/4) defoliation; 41-60% defoliation
3 - 3/4 defoliation; 61-94% defoliation
4 - complete (4/4) defoliation; 95% or more defoliation

The proper code symbol is entered on the card (SB 5230-1) for each twig.

6. Egg-mass counting - the number of egg-masses are recorded for each twig, except when the count of 16 is reached for the plot. In the latter case, complete the twig being counted and record the total number. Record 0 for negative egg counts, but leave blank when no counts are made.

Spruce Budworm Evaluation - Superior N.F.

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